

9.0 Sampling Process Design

9.1 SELECTION OF SAMPLING LOCATIONS

A water quality study may involve the collection of samples from any number of different sources (lakes, streams, groundwater, wastewater discharges, drinking water supplies, etc.) and for one or more reasons (planning, research, design, enforcement, or regulation). Whatever the sample source or reason for monitoring, the selected sampling locations must be representative sites. The term "representative point" is defined as "a location in surface waters or ground waters at which specific conditions or parameters may be measured in such a manner as to characterize or approximate the quality or condition of the water body; or a location in process waters or wastewaters where specific conditions or parameters are measured that adequately reflect the actual conditions of those waters or wastewaters ", 40 CFR, Part 35, Subpart 8, Appendix A, at 224 (1986).

The selection of a sampling location must consider:

- A. Homogeneity: Turbulence and good mixing enhance the homogeneity (uniform distribution of constituents) within the body of water or wastewater. Stratification and poor mixing may occur in lakes and rivers downstream of a discharge. Stratification may result from natural temperature gradients or different densities of waterbody constituents (dissolved solids, suspended solids, oils and greases, etc.).
- B. General characteristics of a waterbody or wastewater : Sampling sites representing a mainstream of a water or wastewater, major water use areas (public water supply intakes, recreational areas, fish spawning areas), at the mouths of major tributaries, or in reaches defined by land use or morphologic zones all contribute to an understanding of the characteristics of a water or wastewater.
- C. Pronounced water quality degradation : Critical locations that have the potential for displaying the most pronounced water quality or biological problems shall be considered.
- D. Flow measurement : Locations shall be considered where the corresponding discharges are known or can be estimated.
- E. Convenience, accessibility, and practicability. However, these shall be secondary to the representativeness of the sampling.

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Since water quality varies from place to place in most water systems, and over time at the same place, locations appropriate to the information needs of a particular program must be selected.

9.1.1 Selection of Surface Water Sampling Locations

The sampling of surface waters may involve the collection of water, sediment, and biological (benthic macroinvertebrates, algae, fish, etc.) samples. Most surface water quality surveys conducted by DEQ emphasize the collection of water samples for water chemistry data over sediment and biological sample collection. Collected biological samples are almost exclusively benthic macroinvertebrates and periphyton. The following guidelines are for the selection of surface water sampling locations although they are applicable to the collection of biological samples where the aquatic biology is expected to reflect the water quality.

A. Ideally, a sampling location shall be near a streamflow gaging station so that the water quality can be related to the discharge. If no gaging station is at or near the sampling site, an effort shall be made to measure the flow with a portable flow meter. If a flow cannot be measured, an estimate of flow shall be made.

B. If a sample collection site is downstream from the confluence of two streams or from a point source of pollution, the collection of a representative sample may be difficult. Visual observation or field measurements (specific conductance, temperature, pH, etc.) across the cross-section shall verify that the flow at the sampling location is mixed. Generally, flow downstream of the confluence of a discharge or tributary shall be completely mixed after two meander traverses.

C. Selection of a sampling site just upstream from the confluence of two streams or a discharge can result in an unrepresentative sample unless the distance upstream from the confluence is sufficient to reduce backwater effects.

D. After a sampling site has been selected , samples are collected at the same location throughout the period of record, if possible. However, this does not mean that the location sampled during high flow would necessarily be most representative (mixing, flow velocity, sediment transport, etc.) of conditions during low flow.

E. Sampling stations selected for a monitoring program shall be critically reviewed to ensure that the data generated from the collected and analyzed water, sediment or biological samples provide the information required to meet the objectives of the monitoring program.

9.1.2 Selection of Wastewater Sampling Locations

Wastewater sampling is an integral part of the DEQ Compliance Monitoring Program, but may also be important in the conduct of Intensive Surveys. DEQ permits contain specific and legally enforceable effluent limitations and self-monitoring requirements for effluent sampling and flow measurement. However, sample collection for other programs or for other objectives may require the collection of samples from locations other than those specified in the permit.

Guidelines for the selection of wastewater sampling locations are as follows:

- A. Collect samples at locations specified in the permit unless they clearly do not meet the objectives of the monitoring program. Samples for BOD analyses shall be collected before disinfection.
- B. Influent wastewaters shall be sampled at points of highly turbulent flow to ensure good mixing. Preferred sampling points are:
 - 1. The upflow syphon following a communicator (in absence of grit chamber) ;
 - 2. The upflow distribution box following pumping from main plant wet well ;
 - 3. An aerated grit chamber;
 - 4. A flume throat; and
 - 5. A pump wet well.

In all cases, samples shall be collected upstream from the recirculated plant supernatant and sludges.

C. Effluent samples shall be collected at the site specified in the permit, or if no site is specified in the permit, at the most representative site downstream from all entering waste streams before entry into the receiving water.

9.1.3 Groundwater Site Selection

The relationship of the following factors to potential pollution sources shall be considered and evaluated when selecting ground-water sampling sites:

- A. The direction of ground-water flow, depth to ground water, thickness of the aquifer (if applicable);
- B. Type of stratigraphy;
- C. Presence of perched water tables ;
- D. Types of soils;
- E. Depth to bedrock;
- F. Type of vegetation;
- G. Surface drainage patterns ;
- H. Type of topography;
- I. General land use; and
- J. Surface features such as rock outcrops, seeps, springs, streams, rivers, and wet areas.

The area of interest shall be located on an aerial photograph, a USGS 7.5 minute quadrangle map, a USDA soils map, and/or any other appropriate map that shows topography and general relationships between surface features. Aerial photographs can usually be obtained at the local Agricultural Stabilization Conservation Service (ASCS) office or the local county tax office. USGS 7.5 minute quadrangle maps can be acquired from the State Geological Survey or from the USGS; soils maps can be obtained from the USDA-SCS (Soil Conservation Service).

A visual inspection of the area may be sufficient to evaluate and determine the surface conditions and their relationship to the subsurface conditions (See Section 11.4.3). Sometimes, surface and subsurface conditions cannot be correlated by site inspection or reconnaissance. When this occurs, a more detailed study, possibly involving test drilling, must be conducted.

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Sampling the unconfined or surficial aquifer downgradient of potential pollution sources or spills (the most easily contaminated aquifer) to determine if it has been affected is extremely important. Generally the direction of groundwater flow can be estimated by two vectors - one in the direction of surface water flow (i.e., downstream) and another toward the nearest surface water stream or river, if present. The relative magnitude of these vectors shall vary according to site conditions and in some instances, both direction and magnitude may be changed by construction activities. If both a shallow and a deep aquifer are involved in the zone of interest, a screening study shall reveal whether the deep aquifer shall be sampled and a more detailed study is required.

To assess subsurface conditions adequately, a minimum of three wells is required : one in the upgradient portion of the area of interest, one in the middle portion, and one in the downgradient portion. In some cases, a more complex system of wells may be needed to define the subsurface conditions, especially in establishing the depth to the shallow groundwater aquifer and the direction of groundwater movement.

Site conditions and the scope of the project shall determine the total number of wells required. Existing wells shall be used when possible.

9.2 IDENTIFYING SITE LOCATIONS

9.2.1 Using Maps To Locate Sites

Several maps are useful for identifying site locations. One of the most useful and detailed maps is the topographic map produced by the United States Geological Survey. These maps are published as 7.5 and 15 minute series (scales 1:24,000 and 1:62,500, respectively) with 40 and 80ft contours, respectively.

A topographic map includes geographic features, roads, trails, mining sites, buildings, and major public land ownership. Location descriptions are given as a legal description (township, range and section) and as latitude/longitude (degrees, minutes, and seconds).

The DEQ has a set of topographic maps for the entire state with an index guide and map to assist in identifying the appropriate map for the area of interest. The DEQ also has a program in AREV (Store-ease station requests) that determines the site location's appropriate latitude and longitude using legal description inputs.

Another useful resource to identify site locations is the Montana Atlas and Gazetteer. The Montana Atlas has topographical maps for the entire state with a scale of 1:250,000 with 100 ft contours. Although the atlas has a larger scale than the 7.5 or 15 minute series individual topographical maps, they do provide more detailed public land ownership information.

The atlas identifies locations of areas owned by the State of Montana, Bureau of Land Management (BLM), National Forest Service (USFS), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), and Indian Reservations. The Montana Atlas and Gazetteer can be obtained at most local book stores.

Other maps that can be helpful in site locations include USFS, BLM, USFWS, NPS, Tribal and county maps. These maps vary in scale and detail but are often the most practical and useful to find general locations and ownerships. These maps can be purchased from the appropriate agencies. If more detailed land ownership information is desired, a county plat map can be found at the county courthouse or local conservation district.

Aerial photography is useful if more detailed topographic features or land use patterns are necessary. Aerial photographs may be available through the USFS or the Natural Resources Conservation Service (NRCS).

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The DEQ has developed and distributed maps for Montana with hydrologic segment plots to assist in determining the associated hydrologic unit codes for the site location.

Geographic Information System (GIS) map coverage can be obtained from the Montana State Library. GIS coverage may include political boundaries, land use, climatic, geologic, hydrologic, and other information. The GIS coverage is constantly being updated and therefore the mapping capabilities shall improve in the future. A GIS map can be made at any desired scale.

9.2.2 Using The Global Positioning System

An alternative method for determining site locations is the Global Positioning System (GPS). Several compact hand-held GPS receivers are currently on the market. The DEQ is currently using the Ensign GPS from Trimble Navigation.

The GPS system was developed by the U.S. Department of Defense and receives signals from 24 satellites orbiting the earth twice a day. GPS receivers use these satellites as reference points to triangulate their position by measuring the travel time of a signal transmitted from each satellite and computing its distance from the satellite. The receiver can calculate position, altitude, and velocity if it receives simultaneous signals from at least four satellites.

The precision and accuracy of the measurement are determined by the geometric arrangements of the satellites. This geometric arrangement is known as Dilution of Precision (also known as DOP, HDOP or PDOP). The higher the DOP, the lower the accuracy. To insure accuracy, make sure the DOP is less than 5.0. Satellite readings can be blocked by obstructions such as trees, mountains, etc. If only three satellites are visible by the receiver, it can derive a two dimensional fix if the altitude is specified by the user. The satellite data screen may be useful locating the satellites and allowing for the receiver to be positioned accordingly.

Before using the GPS receiver, make sure that it has been initialized and has a complete updated satellite almanac. The initializing process may take up to 30 minutes. It shall only take several minutes to acquire a GPS position fix after the initialization if no major obstructions for viewing the satellites are present. Simply turn the receiver on and hold it so the antenna is facing the sky; make sure the antenna is exposed to the horizon and press the "POS" key to view the position screen. The position screen displays your position in latitude and longitude (degrees and minutes), altitude (feet), the number of satellites being tracked, and the DOP. The position fix can be determined in both three-dimension (3-D) or two-dimension (2-D) if the user inputs the altitude.

Other information provided by the GPS system includes time, date, and navigation.

The GPS, system if properly used with at least four satellites (3-D) or three satellites (2-D), and a DOP or HDOP less than 5.0, will provide an accuracy of 2 - 32 meters. Altitude, however, may be off several hundred feet. For quality assurance, always check the GPS outputs with a

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topographical map at the time the locations are being determined to insure that no gross errors have been made.

In addition to the hand-held GPS receivers, the DEQ also has (2) GPS units that can be used where accuracy of less than 2 - 32 meters is required. These units have an accuracy in the centimeter range when determining horizontal position. However, the units are not nearly as compact as the hand held models and are much more expensive.

Refer to the appropriate owner's manuals for additional information.

9.2.3 System For Geographic Location Of Features

Wells, springs, water-sampling locations, and stream-gaging locations are assigned numbers based on the system of land subdivision used by the U.S. Bureau of Land Management.

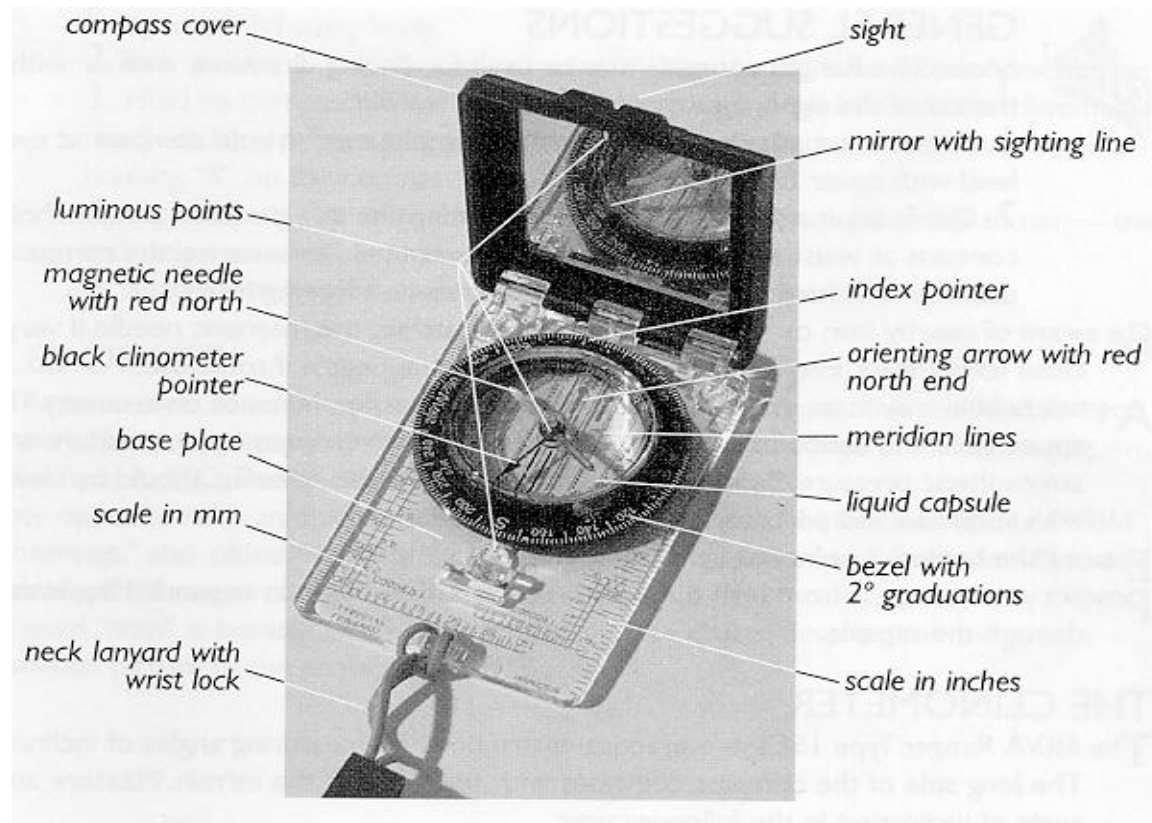
The number consists of twelve characters and describes the location by township, range, section, and position within the section. The figure below illustrates the numbering method.

First three characters of the number give the township, and the next three characters the range. The next two numbers give the section number within the township. The next three letters describe the location within the quarter section (160-acre tract) and the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). These subdivisions of the 640-acre section are designated as a, b, c, and d in a counterclockwise direction, beginning in the northeast quadrant.

If more than one feature in a 10-acre tract, consecutive digits beginning with two are added to the number. For example, if a water-quality sample was collected in Sec.21,T.9N.,R20W, it would be numbered 09N20W21DAA2. The letters, DAA, indicate that the well is in the NE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of the SE $\frac{1}{4}$, and the number 2 following the letters DAA indicates there is more than one water-quality sampling location in this 10-acre tract. See Figure 1.

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9.2.4 Methods for using Compass and Clinometer



Silva Ranger Type 15CL

DEQ stream assessment procedures involve the use of a compass to determine the orientation of photos for photo points, and the clinometer to determine slope aspects of streams. The model used at this time is the Silva Ranger Type 15CL. The following procedures are used to take a bearing between your position and a permanent landmark, as well as determine the slope aspect of a stream using the clinometer.

To use the compass to determine the direction the photographer is facing when a photo was taken, stand at that point and hold the compass flat with the index arrow pointing the same direction as the camera. Align the north end of the orienting arrow with the north end of the needle. The reading at the index arrow is the direction you are facing.

To take a compass bearing of your location, find two permanent landmarks that will not be washed away by a flood or other natural disturbance. They should be fairly far apart from each other, since they will be used to form a triangle with your position. Hold the compass at eye level with the sighting mirror open enough that you can see the orienting arrow and the index arrow in the mirror.

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Sight in the first landmark by viewing it through the sight on the compass. Then align the north end of the orienting arrow with the north end of the needle by rotating the bezel. The number read at the index pointer is the first bearing. Repeat this procedure for the second landmark, and record both of these readings in your field notebook. Straight lines drawn along each of these bearings on a map will intersect at your position.

To use the clinometer to determine slope aspect, open the compass and turn the bezel so that the point West is aligned with the index pointer. Hold the compass at arms length so that the point South on the bezel faces the ground, and align the edge of the compass so that it is parallel with the slope of the stream. The angle of inclination is read at the tip of the clinometer needle.